

SCIENCE

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ADDRESS OF THE PRESIDENT, SIR DOUGLAS GALTON, BEFORE THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

My first duty is to convey to you, Mr. Mayor, and to the inhabitants of Ipswich, the thanks of the British Association for your hospitable invitation to hold our sixty-fifth meeting in your ancient town, and thus to recall the agreeable memories of the similar favor which your predecessors conferred on the Association forty-four years ago.

In the next place I feel it my duty to say a few words on the great loss which science has recently sustained—the death of the Right Hon. Thomas Henry Huxley. It is unnecessary for me to enlarge, in the presence of so many to whom his personality was known, upon his charm in social and domestic life; but upon the debt which the Association owes to him for the assistance which he rendered in the promotion of science I cannot well be silent. Huxley was preëminently qualified to assist in sweeping away the obstruction by dogmatic authority, which in the early days of the Association fettered progress in certain branches of science. For, whilst he was an eminent leader in biological research, his intellectual power, his original and intrepid mind, his vigorous and masculine English, made him a writer who explained the deepest subject with transparent clearness. And

as a speaker his lucid and forcible style was adorned with ample and effective illustration in the lecture room; and his energy and wealth of argument in a more public arena largely helped to win the battle of evolution, and to secure for us the right to discuss questions of religion and science without fear and without favor. It may, I think, interest you to learn that Huxley first made the acquaintance of Tyndall at the meeting of the Association held in this town in 1851.

About forty-six years ago I first began to attend the meetings of the British Association; and I was elected one of your general secretaries about twenty-five years ago. It is not unfitting, therefore, that I should recall to your minds the conditions under which science was pursued at the formation of the Association, as well as the very remarkable position which the Association has occupied in relation to science in this country. Between the end of the sixteenth century and the early part of the present century several societies had been created to develop various branches of science. Some of these societies were established in London, and others in important provincial centers. In 1831, in the absence of railways, communication between different parts of the country was slow and difficult. Science was therefore localised; and in addition to the universities in England, Scotland and Ireland, the towns of Birmingham, Manchester, Plymouth and York each maintained an important nucleus of scientific research.

Under these social conditions the British Association was founded in September, 1831. The general idea of its formation was derived from a migratory society which had been previously formed in Germany; but whilst the German society met for the special occasion on which it was summoned, and then dissolved, the basis of the British Association was continuity. The objects of

the founders of the British Association were enunciated in their earliest rules to be:

"To give a stronger impulse and a more systematic direction to scientific inquiry; to promote the intercourse of those who cultivated science in different parts of the British Empire with one another, and with foreign philosophers; to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress."

Thus the British Association for the Advancement of Science based its utility upon the opportunity it afforded for combination.

The first meeting of the Association was held at York with 353 members. As an evidence of the want which the Association supplied, it may be mentioned that at the second meeting, which was held at Oxford, the number of members was 435. The third meeting, at Cambridge, numbered over 900 members, and at the meeting at Edinburgh in 1834 there were present 1,298 members.

At its third meeting, which was held at Cambridge in 1833, the Association, through the influence it had already acquired, induced the Government to grant a sum of £500 for the reduction of the astronomical observations of Baily. And at the same meeting the General Committee commenced to appropriate to scientific research the surplus from the subscriptions of its members. The committees on each branch of science were desired "to select definite and important objects of science, which they may think most fit to be advanced by an application of the funds of the society, either in compensation for labor, or in defraying the expenses of apparatus, or otherwise, stating their reasons for their selection, and, when they may think proper, designating individuals to undertake the desired investigations." The several proposals were submitted to the Committee of Recommendations, whose approval was necessary before they could be passed by the General Committee.

The regulations then laid down still guide the Association in the distribution of its grants. At that early meeting the Association was enabled to apply £600 to these objects.

I have always wondered at the foresight of the framers of the constitution of the British Association, the most remarkable feature of which is the lightness of the tie which holds it together. It is not bound by any complex central organization. It consists of a federation of Sections, whose youth and energy are yearly renewed by a succession of Presidents and Vice-Presidents, whilst in each Section some continuity of action is secured by the less movable Secretaries.

The governing body is the General Committee, the members of which are selected for their scientific work; but their controlling power is tempered by the law that all changes of rules, or of constitution, should be submitted to, and receive the approval of, the Committee of Recommendations. This Committee may be described as an ideal Second Chamber. It consists of the most experienced members of the Association. The administration of the Association in the interval between annual meetings is carried on by the Council, an executive body, whose duty it is to complete the work of the annual meeting (*a*) by the publication of its Proceedings; (*b*) by giving effect to resolutions passed by the General Committee; (*c*) it also appoints the Local Committee and organizes the *personnel* of each Section for the next meeting. I believe that one of the secrets of the long-continued success and vitality of the British Association lies in this purely democratic constitution, combined with the compulsory careful consideration which must be given to suggested organic changes.

The Association is now in the sixty-fifth year of its existence. In its origin it invited the philosophical societies dispersed

throughout Great Britain to unite in a coöperative union. Within recent years it has endeavored to consolidate that union. At the present time almost all important local scientific societies scattered throughout the country, some sixty-six in number, are in correspondence with the Association. Their delegates hold annual conferences at our meetings. The Association has thus extended the sphere of its action; it places the members of the local societies engaged in scientific work in relation with each other, and brings them into coöperation with members of the Association and with others engaged in original investigations, and the papers which the individual societies publish annually are catalogued in our report. Thus by degrees a national catalogue will be formed of the scientific work of these societies. The Association has, moreover, shown that its scope is coterminous with the British Empire by holding one of its annual meetings at Montreal, and we are likely soon to hold a meeting in Toronto.

The Association, at its first meeting, began its work by initiating a series of reports upon the then condition of the several sciences. A rapid glance at some of these reports will not only show the enormous strides which have been made since 1831 in the investigation of facts to elucidate the laws of nature, but it may afford a slight insight into the impediments offered to the progress of investigation by the mental condition of the community, which had been for so long satisfied to accept assumptions without undergoing the labor of testing their truth by ascertaining the real facts. This habit of mind may be illustrated by two instances selected from the early reports made to the Association. The first is afforded by the report made in 1832, by Mr. Lubbock, on 'Tides.'

This was a subject necessarily of importance to England as a dominant power at sea. But in England records of the tides

had only recently been commenced at the dockyards of Woolwich, Sheerness, Portsmouth and Plymouth, on the request of the Royal Society, and no information had been collected upon the tides on the coasts of Scotland and Ireland. The British Association may feel pride in the fact that within three years of its inception, viz. by 1834, it had induced the Corporation of Liverpool to establish two tide gauges, and the Government to undertake tidal observations at 500 stations on the coasts of Britain.

Another cognate instance is exemplified by a paper read at the second meeting, in 1832, upon the State of Naval Architecture in Great Britain. The author contrasts the extreme perfection of the carpentry of the internal fittings of the vessels with the remarkable deficiency of mathematical theory in the adjustment of the external form of vessels, and suggests the benefit of the application of refined analysis to the various practical problems which ought to interest shipbuilders—problems of capacity, of displacement, of stowage, of velocity, of pitching and rolling, of masting, of the effects of sails and of the resistance of fluids; and, moreover, suggests that large-scale experiments should be made by Government, to afford the necessary data for calculation.

Indeed, when we consider how completely the whole habit of mind of the populations of the western world has been changed, since the beginning of the century, from willing acceptance of authority as a rule of life to a universal spirit of inquiry and experimental investigation, is it not probable that this rapid change has arisen from society having been stirred to its foundations by the causes and consequences of the French Revolution?

One of the earliest practical results of this awakening in France was the conviction that the basis of scientific research lay in the accuracy of the standards by which

observations could be compared; and the following principles were laid down as a basis for their measurements of length, weight and capacity, viz.: (1) That the unit of linear measure applied to matter in its three forms of extension, viz.: length, breadth and thickness, should be the standard of measures of length, surface and solidity; (2) that the cubic contents of the linear measure in decimeters of pure water at the temperature of its greatest density should furnish at once the standard weight and the measure of capacity.* The metric system did not come into full operation in France till 1840; and it is now adopted by all countries on the continent of Europe except Russia.

The standards of length which were accessible in Great Britain at the formation of the Association were the Parliamentary standard yard lodged in the Houses of Parliament (which was destroyed in 1834 in the fire which burned the Houses of Parliament), the Royal Astronomical Society's standard and the 10-foot bar of the Ordnance Survey. The first two were assumed to afford exact measurements at a given temperature. The Ordnance bar was formed of two bars on the principle of a compensating pendulum, and afforded measurements independent of temperature. Standard bars were also disseminated throughout the country, in possession of the corporations of various towns.

The British Association early recognized the importance of uniformity in the record of scientific facts, as well as the necessity for an easy method of comparing standards and for verifying differences between instruments and apparatus required by various observers pursuing similar lines of investi-

* The liter is the volume of a kilogramme of pure water at its maximum density, and is slightly less than the liter was intended to be, viz., one cubic decimeter. The weight of a cubic decimeter of pure water is 1.000013 kilogrammes.

gation. At its meeting at Edinburgh in 1834 it caused a comparison to be made between the standard bar at Aberdeen, constructed by Troughton, and the standard of the Royal Astronomical Society, and reported that the scale "was exceedingly well finished; it was about $\frac{1}{800}$ of an inch shorter than the five-feet of the Royal Astronomical Society's scale, but it was evident that a great number of minute, yet important, circumstances have hitherto been neglected in the formation of such scales, without an attention to which they cannot be expected to accord with that degree of accuracy which the present state of science demands." Subsequently, at the meeting at Newcastle in 1863, the Association appointed a committee to report on the best means of providing for a uniformity of weights and measures with reference to the interests of science. This committee recommended the metric decimal system—a recommendation which has been endorsed by a committee of the House of Commons in the last session of last Parliament.

British instrument makers had been long conspicuous for accuracy of workmanship. Indeed, in the eighteenth century practical astronomy had been mainly in the hands of British observers; for although the mathematicians of France and other countries on the continent of Europe were occupying the foremost place in mathematical investigation, means of astronomical observation had been furnished almost exclusively by English artisans.

The sectors, quadrants and circles of Ramsden, Bird and Carey were inimitable by continental workmen. But the accuracy of the mathematical instrument maker had not penetrated into the engineer's workshop. And the foundation of the British Association was coincident with a rapid development of mechanical appliances. At that time a good workman had done well if the shaft he was turning, or the cyl-

inder he was boring, 'was right to the $\frac{1}{32}$ of an inch.' This was, in fact, a degree of accuracy as fine as the eye could usually distinguish.

Few mechanics had any distinct knowledge of the method to be pursued for obtaining accuracy; nor, indeed, had practical men sufficiently appreciated either the immense importance or the comparative facility of its acquisition. The accuracy of workmanship essential to this development of mechanical progress required very precise measurements of length, to which reference could be easily made. No such standards were then available for the workshops. But a little before 1830 a young workman named Joseph Whitworth realized that the basis of accuracy in machinery was the making of a true plane. The idea occurred to him that this could only be secured by making three independent plane surfaces; if each of these would lift the other they must be planes and they must be true.

The true plane rendered possible a degree of accuracy beyond the wildest dreams of his contemporaries in the construction of the lathe and the planing machine, which are used in the manufacture of all tools. His next step was to introduce an exact system of measurement, generally applicable in the workshop.

Whitworth felt that the eye was altogether inadequate to secure this, and appealed to the sense of touch for affording a means of comparison. If two plugs be made to fit into a round hole they may differ in size by a quantity imperceptible to the eye, or to any ordinary process of measurement, but in fitting them into the hole the difference between the larger and the smaller is felt immediately by the greater ease with which the smaller one fits. In this way a child can tell which is the larger of two cylinders differing in thickness by no more than $\frac{1}{800}$ of an inch.

Standard gauges, consisting of hollow cylinders with plugs to fit, but differing in diameter by the $\frac{1}{100}$ or the $\frac{1}{10000}$ of an inch, were given to his workmen, with the result that a degree of accuracy inconceivable to the ordinary mind became the rule of the shop.

To render the construction of accurate gauges possible, Whitworth devised his measuring machine, in which the movement was affected by a screw; by this means the distance between two true planes might be measured to the one-millionth of an inch.

These advances in precision of measurement have enabled the degree of accuracy which was formerly limited to the mathematical instrument maker to become the common property of every machine shop. And not only is the latest form of steam engine, in the accuracy of its workmanship, little behind the chronometer of the early part of the century, but the accuracy in the construction of experimental apparatus which has thus been introduced has rendered possible recent advances in many lines of research.

Lord Kelvin said, in his Presidential Address at Edinburgh, "Nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient, long-continued labor in the sifting of numerical results." The discovery of argon, for which Lord Rayleigh and Prof. Ramsay have been awarded the Hodgkin prize by the Smithsonian Institution, affords a pregnant illustration of the truth of this remark. Indeed, the provision of accurate standards not only of length, but of weight, capacity, temperature, force and energy, are amongst the foundations of scientific investigation.

In 1842 the British Association obtained the opportunity of extending its usefulness in this direction. In that year the Government gave up the Royal Observatory at Kew

and offered it to the Royal Society, who declined it. But the British Association accepted the charge. Their first object was to continue Sabine's valuable observations upon the vibrations of a pendulum in various gases, and to promote pendulum observations in different parts of the world. They subsequently extended it into an observatory for comparing and verifying the various instruments which recent discoveries in physical science had suggested for continuous meteorological and magnetic observations, for observations and experiments on atmospheric electricity, and for the study of solar physics.

This new departure afforded a means for ascertaining the advantages and disadvantages of the several varieties of scientific instruments, as well as for standardizing and testing instruments, not only for instrument makers, but especially for observers by whom simultaneous observations were then being carried on in different parts of the world, and also for training observers proceeding abroad on scientific expeditions. Its special object was to promote original research, and expenditure was not to be incurred on apparatus merely intended to exhibit the necessary consequences of known laws.

The rapid strides in electrical science had attracted attention to the measurement of electrical resistances, and in 1859 the British Association appointed a special committee to devise a standard. The standard of resistance proposed by that committee became the generally accepted standard, until the requirements of that advancing science led to the adoption of an international standard.

In 1866 the Meteorological Department of the Board of Trade entered into close relations with the Kew Observatory, and in 1871 Mr. Gassiot transferred £10,000 upon trust to the Royal Society for the maintenance of the Kew Observatory,

for the purpose of assisting in carrying on magnetical, meteorological and other physical observations. The British Association thereupon, after having maintained this Observatory for nearly thirty years, at a total expenditure of about £12,000, handed the Observatory over to the Royal Society.

The *Transactions* of the British Association are a catalogue of its efforts in every branch of science, both to promote experimental research and to facilitate the application of the results to the practical uses of life. But probably the marvellous development in science which has accompanied the life-history of the Association will be best appreciated by a brief allusion to the condition of some of the branches of science in 1831 as compared with their present state.

At the foundation of the Association geology was assuming a prominent position in science. The main features of English geology had been illustrated as far back as 1821, and among the founders of the British Association, Murchison and Phillips, Buckland, Sedgwick and Conybeare, Lyell and De la Beche were occupied in investigating the data necessary for perfecting a geological chronology by the detailed observations of the various British deposits, and by their correlation with the continental strata. They are thus preparing the way for those large generalizations which have raised geology to the rank of an inductive science.

In 1831 the ordnance maps published for the southern counties had enabled the Government to recognize the importance of a geological survey by the appointment of Mr. De la Beche to affix geological colors to the maps of Devonshire and portions of Somerset, Dorset and Cornwall; and in 1835 Lyell, Buckland and Sedgwick induced the Government to establish the Geological Survey Department, not only for promoting geological science, but on account of its practical bearing on agriculture,

mining, the making of roads, railways and canals, and on other branches of national industry.

The ordnance survey appears to have had its origin in a proposal of the French Government to make a joint measurement of an arc of the meridian. This proposal fell through at the outbreak of the Revolution, but the measurement of the base for that object was taken as a foundation for a national survey. In 1831, however, the ordnance survey had only published the 1-inch map for the southern portion of England, and the great triangulation of the kingdom was still incomplete.

In 1834 the British Association urged upon the Government that the advancement of various branches of science was greatly retarded by the want of an accurate map of the whole of the British Isles; and that, consequently, the engineer and meteorologist, the agriculturist and geologist, were each fettered in their scientific investigations by the absence of those accurate data which now lie ready to his hand for the measurement of length, of surface and of altitude.

Yet the first decade of the British Association was coincident with a considerable development of geographical research. The Association was persistent in pressing on the Government the specific importance of sending the expedition of Ross to the Antarctic and of Franklin to the Arctic regions. We may trust we are approaching a solution of the geography of the North Pole; but the Antarctic regions still present a field for the researches of the meteorologist, the geologist, the biologist and the magnetic observer, which the recent voyage of M. Borchgrevink leads us to hope may not long remain unexplored.

In the same decade the question of an alternative route to India by means of a communication between the Mediterranean and the Persian Gulf was also receiving atten-

tion, and in 1835 the Government employed Colonel Chesney to make a survey of the Euphrates Valley in order to ascertain whether that river would enable a practicable route to be formed from Iskanderoon or Tripoli, opposite Cyprus, to the Persian Gulf. His valuable surveys are not, however, on a sufficiently extensive scale to enable an opinion to be formed as to whether a navigable waterway through Asia Minor is physically practicable, or whether the cost of establishing it might not be prohibitive.

The advances of Russia in Central Asia have made it imperative to provide an easy, rapid and alternative line of communication with our Eastern possessions, so as not to be dependent upon the Suez Canal in time of war. If a navigation cannot be established, a railway between the Mediterranean and the Persian Gulf has been shown by the recent investigations of Messrs. Hawkshaw and Hayter, following on those of others, to be perfectly practicable and easy of accomplishment; such an undertaking would not only be of strategical value, but it is believed it would be commercially remunerative.

Speke and Grant brought before the Association, at its meeting at Newcastle in 1863, their solution of the mystery of the Nile basin, which had puzzled geographers from the days of Herodotus; and the efforts of Livingstone and Stanley and others have opened out to us the interior of Africa. I cannot refrain here from expressing the deep regret which geologists and geographers, and indeed all who are interested in the progress of discovery, feel at the recent death of Joseph Thomson. His extensive, accurate and trustworthy observations added much to our knowledge of Africa, and by his premature death we have lost one of its most competent explorers.

The report made to the Association on the state of the chemical sciences in 1832

says that the efforts of investigators were then being directed to determining with accuracy the true nature of the substances which compose the various products of the organic and inorganic kingdoms, and the exact ratios by weight which the different constituents of these substances bear to each other.

But since that day the science of chemistry has far extended its boundaries. The barrier has vanished which was supposed to separate the products of living organisms from the substances of which minerals consist, or which could be formed in the laboratory. The number of distinct carbon compounds obtainable from organisms has greatly increased; but it is small when compared with the number of such compounds which have been artificially formed. The methods of analysis have been perfected. The physical, and especially the optical, properties of the various forms of matter have been closely studied, and many fruitful generalizations have been made. The form in which these generalizations would now be stated may probably change, some, perhaps, by the overthrow or disuse of an ingenious guess at nature's workings, but more by that change which is the ordinary growth of science—namely, inclusion in some simpler and more general view.

In these advances the chemist has called the spectroscope to his aid. Indeed, the existence of the British Association has been practically coterminous with the comparatively newly developed science of spectrum analysis, for though Newton,* Wol-

* Joannes Marcus Marci, of Kronland in Bohemia, was the only predecessor of Newton who had any knowledge of the formation of a spectrum by a prism. He not only observed that the colored rays diverged as they left the prism, but that a colored ray did not change in color after transmission through a prism. His book, *Thaumantias, liber de arcu cælesti deque colorum apparentium natura*, Prag. 1648, was, however, not known to Newton, and had no influence upon future discoveries.

laston, Fraunhofer and Fox Talbot had worked at the subject long ago, it was not till Kirchhoff and Bunsen set a seal on the prior labors of Stokes, Ångström and Balfour Stewart that the spectra of terrestrial elements were mapped out and grouped; that by its help new elements were discovered, and that the idea was suggested that the various orders of spectra of the same element are due to the existence of the element in different molecular forms—allo-tropic or otherwise—at different temperatures.

But great as have been the advances of terrestrial chemistry through its assistance, the most stupendous advance which we owe to the spectroscope lies in the celestial direction. In the earlier part of this century, whilst the sidereal universe was accessible to investigators, many problems outside the solar system seemed to be unapproachable.

At the third meeting of the Association, at Cambridge, in 1833, Dr. Whewell said that astronomy is not only the queen of science, but the only perfect science, which was "in so elevated a state of flourishing maturity that all that remained was to determine with the extreme of accuracy the consequences of its rules by the profoundest combinations of mathematics, the magnitude of its data by the minutest scrupulousness of observation."

But in the previous year, viz., 1832, Airy, in his report to the Association on the progress of astronomy, had pointed out that the observations of the planet Uranus could not be united in one elliptic orbit—a remark which turned the attention of Adams to the discovery of Neptune. In his report on the position of optical science in 1832, Brewster suggested that with the assistance of adequate instruments "it would be possible to study the action of the elements of material bodies upon rays of artificial light, and thereby to discover the analogies be-

tween their affinities and those which produce the fixed lines in the spectra of the stars, and thus to study the effects of the combustions which light up the suns of other systems."

This idea has now been realized. All the stars which shine brightly enough to impress an image of the spectrum upon a photographic plate have been classified on a chemical basis. The close connection between stars and nebulae has been demonstrated; and while on the one hand the modern science of thermodynamics has shown that the hypothesis of Kant and Laplace on stellar formation is no longer tenable, inquiry has indicated that the true explanation of stellar evolution is to be found in the gradual condensation of meteoritic particles, thus justifying the suggestions put forward long ago by Lord Kelvin and Prof. Tait.

We now know that the spectra of many of the terrestrial elements in the chromosphere of the sun differ from those familiar to us in our laboratories. We begin to glean the fact that the chromospheric spectra are similar to those indicated by the absorption going on in the hottest stars, and Lockyer has not hesitated to affirm that these facts would indicate that in those localities we are in the presence of the actions of temperatures sufficiently high to break up our chemical elements into finer forms. Other students of these phenomena may not agree in this view, and possibly the discrepancies may be due to default in our terrestrial chemistry. Still, I would recall to you that Dr. Carpenter, in his Presidential Address at Brighton in 1872, almost censured the speculations of Frankland and Lockyer in 1868 for attributing a certain bright line in the spectrum of solar prominences (which was not identifiable with that of any known terrestrial source of light) to a hypothetical new substance which they proposed to call 'helium,' because "it had

not received that verification which, in the case of Crookes' search for thallium, was afforded by the actual discovery of the new metal." Ramsay has now shown that this gas is present in dense minerals on earth; but we have now also learned from Lockyer that it and other associated gases are not only found with hydrogen in the solar chromosphere, but that these gases, with hydrogen, form a large percentage of the atmospheric constituents of some of the hottest stars in the heavens.

The spectroscope has also made us acquainted with the motions and even the velocities of those distant orbs which make up the sidereal universe. It has enabled us to determine that many stars, single to the eye, are really double, and many of the conditions of these strange systems have been revealed. The rate at which matter is moving in solar cyclones and winds is now familiar to us. And I may also add that quite recently this wonderful instrument has enabled Prof. Keeler to verify Clerk Maxwell's theory that the rings of Saturn consist of a marvellous company of separate moons—as it were, a cohort of courtiers revolving round their queen—with velocities proportioned to their distances from the planet.

If we turn to the sciences which are included under physics, the progress has been equally marked. In optical science, in 1831, the theory of emission as contrasted with the undulatory theory of light was still under discussion. Young, who was the first to explain the phenomena due to the interference of the rays of light as a consequence of the theory of waves, and Fresnel, who showed the intensity of light for any relative position of the interference waves, both had only recently passed away.

The investigations into the laws which regulate the conduction and radiation of heat, together with the doctrine of latent and of specific heat, and the relations of

vapor to air, had all tended to the conception of a material heat, or caloric, communicated by an actual flow and emission. It was not till 1834 that improved thermometrical appliances had enabled Forbes and Melloni to establish the polarisation of heat, and thus to lay the foundation of an undulatory theory for heat similar to that which was in progress of acceptance for light.

Whewell's report, in 1832, on magnetism and electricity shows that these branches of science were looked upon as cognate, and that the theory of two opposite electric fluids was generally accepted. In magnetism the investigations of Hansteen, Gauss and Weber in Europe, and the observations made under the Imperial Academy of Russia over the vast extent of that Empire, had established the existence of magnetic poles, and had shown that magnetic disturbances were simultaneous at all the stations of observation.

At their third meeting the Association urged the Government to establish magnetic and meteorological observatories in Great Britain and her colonies and dependencies in different parts of the earth, furnished with proper instruments, constructed on uniform principles, and with provisions for continued observations at those places.

In 1839 the British Association had a large share in inducing the Government to initiate the valuable series of experiments for determining the intensity, the declination, the dip and the periodical variations of the magnetic needle which were carried on for several years, at numerous selected stations over the surface of the globe, under the directions of Sabine and Lefroy.

In England systematic and regular observations are still made at Greenwich, Kew and Stonyhurst. For some years past similar observations by both absolute and self-recording instruments have also been made at Falmouth—close to the home of

Robert Were Fox, whose name is inseparably connected with the early history of terrestrial magnetism in this country; but under such great financial difficulties that the continuance of the work is seriously jeopardised. It is to be hoped that means may be forthcoming to carry it on. Cornishmen, indeed, could find no more fitting memorial of their distinguished countryman, John Couch Adams, than by suitably endowing the magnetic observatory in which he took so lively an interest.

Far more extended observation will be needed before we can hope to have an established theory as to the magnetism of the earth. We are without magnetic observations over a large part of the southern hemisphere. And Prof. Rücker's recent investigations tell us that the earth seems as it were alive with magnetic forces, be they due to electric currents or to variations in the state of magnetised matter; that the disturbances affect not only the diurnal movement of the magnet, but that even the small part of the secular change which has been observed, and which has taken centuries to accomplish, is interfered with by some slower agency. And, what is more important, he tells us that none of these observations stand as yet upon a firm basis, because standard instruments have not been in accord; and much labor, beyond the power of individual effort, has hitherto been required to ascertain whether the relations between them are constant or variable.

In electricity, in 1831, just at the time when the British Association was founded, Faraday's splendid researches in electricity and magnetism at the Royal Institution had begun with his discovery of magneto-electric induction, his investigation of the laws of electro-chemical decomposition, and of the mode of electrolytical action. But the practical application of our electrical knowledge was then limited to the use

of lightning conductors for buildings and ships. Indeed, it may be said that the applications of electricity to the use of man have grown up side by side with the British Association.

One of the first practical applications of Faraday's discoveries was in the deposition of metals and electro-plating, which has developed into a large branch of national industry; and the dissociating effect of the electric arc, for the reduction of ores, and in other processes, is daily obtaining a wider extension.

But probably the application of electricity which is tending to produce the greatest change in our mental and even material condition is the electric telegraph and its sister, the telephone. By their agency not only do we learn, almost at the time of their occurrence, the events which are happening in distant parts of the world, but they are establishing a community of thought and feeling between all the nations of the world which is influencing their attitude towards each other, and, we may hope, may tend to weld them more and more into one family.

The electric telegraph was introduced experimentally in Germany in 1833, two years after the formation of the Association. It was made a commercial success by Cooke and Wheatstone in England, whose first attempts at telegraphy were made on the line from Euston to Camden Town in 1837, and on the line from Paddington to West Drayton in 1838. The submarine telegraph to America, conceived in 1856, became a practical reality in 1866 through the commercial energy of Cyrus Field and Pender, aided by the mechanical skill of Latimer Clark, Gooch and others, and the scientific genius of Lord Kelvin. The knowledge of electricity gained by means of its application to the telegraph largely assisted the extension of its utility in other directions.

The electric light gives, in its incandes-

cent form, a very perfect hygienic light. Where rivers are at hand the electrical transmission of power will drive railway trains and factories economically, and might enable each artisan to convert his room into a workshop, and thus assist in restoring to the laboring man some of the individuality which the factory has tended to destroy. In 1843 Joule described his experiments for determining the mechanical equivalent of heat. But it was not until the meeting at Oxford, in 1847, that he fully developed the law of the conservation of energy, which, in conjunction with Newton's law of the conservation of momentum, and Dalton's law of the conservation of chemical elements, constitutes a complete mechanical foundation for physical science.

Who, at the foundation of the Association, would have believed some far-seeing philosopher if he had foretold that the spectroscope would analyze the constituents of the sun and measure the motions of the stars; that we should liquefy air and utilize temperatures approaching to the absolute zero for experimental research; that, like the magician in the 'Arabian Nights,' we should annihilate distance by means of the electric telegraph and the telephone; that we should illuminate our largest buildings instantaneously, with the clearness of day, by means of the electric current; that by the electric transmission of power we should be able to utilize the Falls of Niagara to work factories at distant places; that we should extract metals from the crust of the earth by the same electrical agency to which, in some cases, their deposition has been attributed?

These discoveries and their applications have been brought to their present condition by the researches of a long line of scientific explorers, such as Dalton, Joule, Maxwell, Helmholtz, Herz, Kelvin and Rayleigh, aided by vast strides made in me-

chanical skill. But what will our successors be discussing sixty years hence? How little do we yet know of the vibrations which communicate light and heat! Far as we have advanced in the application of electricity to the uses of life, we know but little even yet of its real nature. We are only on the threshold of the knowledge of molecular action, or of the constitution of the all-pervading ether. Newton, at the end of the seventeenth century, in his preface to the 'Principia,' says: "I have deduced the motions of the planets by mathematical reasoning from forces; and I would that we could derive the other phenomena of nature from mechanical principles by the same mode of reasoning. For many things move me, so that I somewhat suspect that all such may depend on certain forces by which the particles of bodies, through causes not yet known, are either urged towards each other according to regular figures, or are repelled and recede from each other; and these forces being unknown, philosophers have hitherto made their attempts on nature in vain."

In 1848 Faraday remarked: "How rapidly the knowledge of molecular forces grows upon us, and how strikingly every investigation tends to develop more and more their importance. A few years ago magnetism was an occult force, affecting only a few bodies; now it is found to influence all bodies, and to possess the most intimate relation with electricity, heat, chemical action, light, crystallization; and through it the forces concerned in cohesion. We may feel encouraged to continuous labors, hoping to bring it into a bond of union with gravity itself."

But it is only within the last few years that we have begun to realize that electricity is closely connected with the vibrations which cause heat and light, and which seem to pervade all space—vibrations which may be termed the voice of the

Creator calling to each atom and to each cell of protoplasm to fall into its ordained position, each, as it were, a musical note in the harmonious symphony which we call the universe.

At the first meeting, in 1831, Prof. James D. Forbes was requested to draw up a report on the State of Meteorological Science, on the ground that this science is more in want than any other of that systematic direction which it is one great object of the Association to give. Prof. Forbes made his first report in 1832, and a subsequent report in 1840. The systematic records now kept in various parts of the world of barometric pressure, of solar heat, of the temperature and physical conditions of the atmosphere at various altitudes, of the heat of the ground at various depths, of the rainfall, of the prevalence of winds, and the gradual elucidation not only of the laws which regulate the movements of cyclones and storms, but of the influences which are exercised by the sun and by electricity and magnetism, not only upon atmospheric conditions, but upon health and vitality, are gradually approximating meteorology to the position of an exact science.

England took the lead in rainfall observations. Mr. G. J. Symons organized the British Rainfall System in 1860 with 178 observers, a system which until 1876 received the help of the British Association. Now Mr. Symons himself conducts it, assisted by more than 3000 observers, and these volunteers not only make the observations, but defray the expense of their reduction and publication. In foreign countries this work is done by government officers at the public cost. At the present time a very large number of rain gauges are in daily use throughout the world. The British Islands have more than 3000, and India and the United States have nearly as many; France and Germany are not far behind; Australia probably has more—in-

deed, one colony alone, New South Wales, has more than 1100.

The storm warnings now issued under the excellent systematic organization of the Meteorological Committee may be said to have had their origin in the terrible storm which broke over the Black Sea during the Crimean War, on November 27, 1855. Leverrier traced the progress of that storm, and seeing how its path could have been reported in advance by the electric telegraph, he proposed to establish observing stations which should report to the coasts the probability of the occurrence of a storm. Leverrier communicated with Airy, and the government authorized Admiral Fitz Roy to make tentative arrangements in this country. The idea was also adopted on the continent, and now there are few civilized countries north or south of the equator without a system of storm warning.*

(To be concluded.)

ELECTRIFICATION AND DISELECTRIFICATION OF AIR AND OTHER GASES.†

§ 1. EXPERIMENTS were made for the purpose of finding an approximation to the amount of electrification communicated to air by one or more electrified needle points. The apparatus consisted of a metallic can 48 cms. high and 21 cms. in diameter, supported by paraffine blocks, and connected to one pair of quadrants of a quadrant electrometer. It had a hole at the top to admit the electrifying wire, which was 5.31 metres long, hanging vertically within a

* It has often been supposed that Leverrier was also the first to issue a daily weather map, but that was not the case, for in the Great Exhibition of 1851 the Electric Telegraph Company sold daily weather maps, copies of which are still in existence, and the data for them were, it is believed, obtained by Mr. James Glaisher, F. R. S., at that time Superintendent of the Meteorological Department at Greenwich.

† Abstract of a paper by Lord Kelvin, Magnus Maclean and Alexander Galt, read before the British Association for the Advancement of Science.

metallic guard tube. This guard tube was always metallically connected to the other pair of quadrants of the electrometer and to its case, and to a metallic screen surrounding it. This prevented any external influences from sensibly affecting the electrometer, such as the working of the electric machine which stood on a shelf 5 metres above it.

some minutes, so as to electrify the air in the can. As soon as the machine is stopped the electrifying wire is lifted clear out of the can. The can and the quadrants in metallic connection with it are disconnected from the case of the electrometer, and the electrified air is very rapidly drawn away from the can by a blowpipe bellows arranged to suck. This releases the opposite

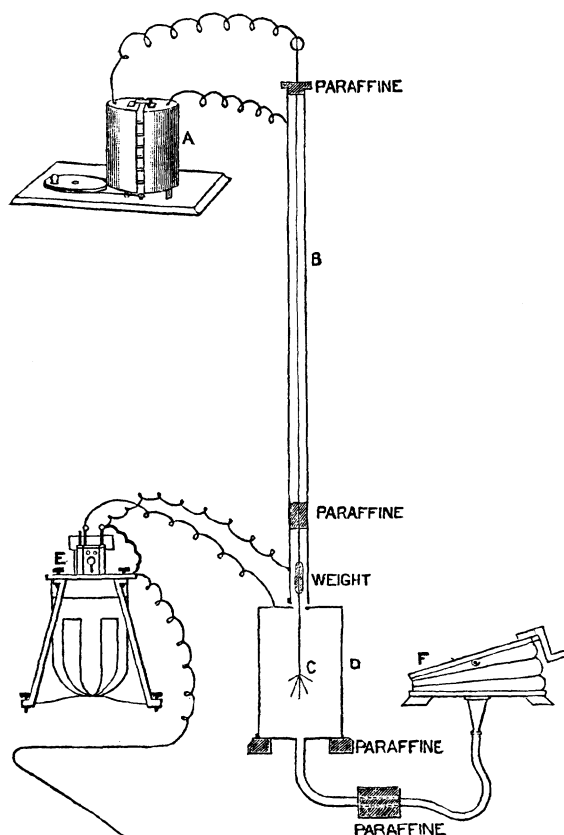


FIG. 1.—Connected with guard screen (not shown in diagram).

§ 2. The experiment is conducted as follows: One terminal of an electric machine is connected with the guard tube and the other with the electrifying wire, which is let down so that the needle is in the centre of the can. The can is temporarily connected to the case of the electrometer. The electric machine is then worked for

kind of electricity from the inside of the can, and allows it to place itself in equilibrium on the outside of the can and on the insulated quadrants of the electrometer in metallic connection with it.

§ 3. We tried different lengths of time of electrification and different numbers of needles and tinsel, but we found that one nee-

dle and four minutes of electrification gave nearly maximum effect. The greatest deflection observed was 936 scale divisions. To find, from this reading, the electric density of the air in the can, we took a metallic disk, of 2 cms. radius, attached to a long varnished glass rod, and placed it at a distance of 1.45 cm. from another and larger metallic disk. This small air condenser was charged from the electric light conductors in the laboratory to a difference of potential amounting to 100 volts. The insulated disk thus charged was removed and laid upon the roof of the large insulated can. This addition to the metal in connection with it does not sensibly influence its electrostatic capacity. The deflection observed was 122 scale divisions. The capacity of the condenser is approximately

$$\frac{\pi \times 2^2}{4\pi \times 1.45} = \frac{1}{1.45}.$$

The quantity of electricity with which it was charged was

$$\frac{1}{1.45} \times \frac{100}{300} = \frac{1}{4.35}$$

electrostatic unit. Hence, the quantity to give 936 scale divisions was

$$\frac{1}{4.35} \times \frac{936}{122} = 1.7637.$$

The bellows was worked vigorously for two and a-half minutes, and in that time all the electrified air would be exhausted. The capacity of the can was 16,632 cubic centimetres, which gives, for the quantity of electricity per cubic centimetre,

$$\frac{1.7637}{16,632} = 1.06 \times 10^{-4}.$$

The electrification of the air in this case was positive; it was about as great as the greatest we got, whether positive or negative, in common air when we electrified it by discharge from needle points. This is about four times the electric density which

we roughly estimated as about the greatest given to the air in the inside of a large metal vat, electrified by a needle point and then left to itself, and tested by the potential of a water dropper with its nozzle in the centre of the vat, in experiments made two years ago and described in a communication to the Royal Society of date May, 1894.*

§ 4. In subsequent experiments, electrifying common air in a large gasholder over water by an insulated gas flame burning within it with a wire in the interior of the flame kept electrified by an electric machine to about 6,000 volts, whether positively or negatively, we found as much as 1.5×10^{-4} for the electric density of the air. Electrifying carbonic acid in the same gasholder, *whether positively or negatively*, by needle points, we obtained an electric density of 2.2×10^{-4} .

§ 5. We found about the same electric density (2.2×10^{-4}) of *negative* electricity in carbonic acid gas drawn from an iron cylinder lying horizontally, and allowed to pass by a U-tube into the gasholder without bubbling through the water. This electrification was due probably not to carbonic acid gas rushing through the stopcock of the cylinder, but to bubbling from the liquid carbonic in its interior, or to the formation of carbonic acid snow in the passages and its subsequent evaporation. When carbonic acid gas was drawn slowly from the liquid carbonic acid in the iron cylinder placed upright, and allowed to pass, without bubbling, through the U-tube into the gasholder over water, no electrification was found in the gas unless electricity was communicated to it from needle points.

§ 6. The electrifications of air and carbonic acid described in Sections 4 and 5 were tested, and their electric densities measured by drawing by an air pump a

* 'On the Electrification of Air,' by Lord Kelvin and Magnus Maclean.

measured quantity of the gas* from the gasholder through an India-rubber tube to a receiver of known efficiency and of known capacity in connection with the electrometer. We have not yet measured how much electricity was lost in the passage through the India-rubber tube. It was not probably nothing; and the electric density of the gas before leaving the gasholder was no doubt greater, though perhaps not much greater, than what it had when it reached the electric receiver.

§ 7. The efficiency of the electric receivers used was approximately determined by putting two of them in series, with a paraffine tunnel between them, and measuring by

in each case. This assumption was approximately justified by the results.

§ 8. Thus we found for the efficiencies of two different receivers respectively 0.77 and 0.31 with air electrified positively or negatively by needle points; and 0.82 and 0.42 with carbonic acid gas electrified negatively by being drawn from an iron cylinder placed on its side. Each of these receivers consisted of block tin pipe, 4 cms. long and 1 cm. diameter, with 5 plugs of cotton wool kept in position by six discs of fine wire gauze. The great difference in their efficiency was no doubt due to the quantities of cotton wool being different, or differently compressed in the two.

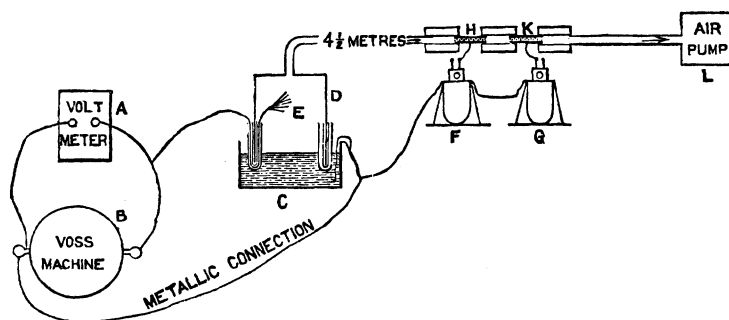


FIG. 2.

means of two quadrant electrometers the quantity of electricity which each took from a measured quantity of air drawn through them. By performing this experiment several times, with the order of the two receivers alternately reversed, we had data for calculating the proportion of the electricity taken by each receiver from the air entering it, on the assumption that the proportion taken by each receiver was the same

* The gasholder was 38 cms. high and 81 cms. in circumference. Ten strokes of the pump raised the water inside to a height of 8.1 cms., so that the volume of air drawn through the receivers in the experiments was 428 cubic centimetres per stroke of the pump. This agrees with the measured effective volume of the two cylinders of the pump.

§ 9. We have commenced and we hope to continue an investigation of the efficiency of electric receivers of various kinds, such as block tin, brass and platinum tubes from 2 to 4 cms. long, and from 1 mm. to 1 cm. internal diameter, all of smooth bore and without any cotton wool or wire gauze filters in them; also a polished metal solid, insulated within a paraffine tunnel. This investigation, made with various quantities of air drawn through per second, has already given us some interesting and surprising results, which we hope to describe after we have learned more by farther experimenting.

§ 10. In addition to our experiments on

electric filters we have made many other experiments to find other means for the dis-electrification of air. It might be supposed that drawing air in bubbles through water should be very effective for this purpose, but we find that this is far from being the case. We had previously found that non-electrified air drawn in bubbles through pure water becomes negatively electrified, and through salt water positively. We now find that positively electrified air drawn through pure water, and negatively electrified air through salt water, has its electrification diminished but not annulled, if the primitive electrification is sufficiently strong. Negatively electrified air drawn in bubbles through pure water, or positively electrified air drawn through salt water, has its electrification augmented.

§ 11. To test the effects of heat we drew air through combustion tubes of German glass about 180 cms. long, and $2\frac{1}{2}$ or $1\frac{1}{2}$ cms. bore, the heat being applied externally to about 120 cms. of the length. We found that, when the temperature was raised to nearly a dull red heat, air, whether positively or negatively electrified, lost little or nothing of its electrification by being drawn through the tube. When the temperature was raised to a dull red heat, and to a bright red, high enough to soften the glass, losses up to as much as four-fifths of the whole electrification were sometimes observed, but never complete diselectrification. The results, however, were very irregular. Non-electrified air never became sensibly electrified by being drawn through the hot glass tubes in our experiments, but it gained strong positive electrification when pieces of copper foil, and negative electrification when pieces of carbon, were placed in the tube, and when the temperature was sufficient to powerfully oxidize the copper or to burn away the charcoal.

§ 12. Through the kindness of Mr. E.

Matthey, we have been able to experiment with a platinum tube 1 metre long and 1 millimetre bore. It was heated either by a gas flame or an electric current. When the tube was cold, and non-electrified air drawn through it, we found no signs of electrification by our receiver and electrometer. But when the tube was made red or white hot, either by gas burners applied externally or by an electric current through the metal of the tube, the previously non-electrified air drawn through it was found to be electrified strongly positive. To get complete command of the temperature we passed a measured electric current through 20 centimetres of the platinum tube. On increasing the current till the tube began to be at a scarcely visible dull red heat we found but little electrification of the air. When the tube was a little warmer, so as to be quite visibly red hot, large electrification became manifest. Thus 60 strokes of the air pump gave 45 scale divisions on the electrometer when the tube was dull red, and 395 scale divisions (7 volts) when it was a bright red (produced by a current of 36 ampères). With stronger currents, raising the tube to white-hot temperature, the electrification seemed to be considerably less.

SCIENCE OR POETRY.

THE hardest of intellectual virtues is philosophic doubt, and the mental vice to which we are most prone is our tendency to assume that lack of evidence for an opinion is a reason for believing something else.

This tendency has value in practical matters which call for action, but the man of science need neither starve nor choose, and suspended judgment is the greatest triumph of intellectual discipline, although vacillation brands the man of affairs with weakness.

Anything which is conceivable may be

good poetry, but science is founded upon the rock of evidence, and we all believe many things which are inconceivable, such as the truth that the image in our eyes is upside down, and we justly repudiate many opinions which are not only quite conceivable but also quite incapable of disproof.

Many persons have found the opinion that all nature is conscious and endowed with volition, that the morning stars sing together, that the waters laugh, that the wind bloweth where it listeth, and that trees talk; not only conceivable but worthy of belief, and it is quite clear that we cannot oppose any belief of this sort, or convert the sailor who believes the wind obeys his whistle, by evidence.

The path of scientific progress is strewn with beliefs which have been abandoned from lack of evidence, as burst shells strew a battlefield, and it is our boast that they are abandoned and not lugged along the line of march.

As a shell which has failed to burst is now and then picked up on some old battlefield by some one on whom experience is thrown away, and is exploded by him with disastrous results in the bosom of his approving family, so one of these abandoned beliefs is sometimes dug up by the head of some scientific family to the intellectual confusion of those who accept him as their leader.

We need not concern ourselves with the beliefs of the unscientific, but the utterances of the heads of learned societies are public acts, approved by the majority of the members. They come before the public with authority, and they are regarded by the world as the expressions of the mature judgment of American men of science.

In a recent number of SCIENCE (p. 210) a 'President' quotes the opinion 'of a chemist, a physicist and a biologist,' to the effect that they cannot conceive how the problems of biology are to be referred to

mechanical energy and physical matter; and he tells us furthermore that "it can be stated without fear of refutation that every physiological investigation shows with accumulating emphasis that the manifestations of living matter are not explicable only with the forces of dead matter."

The assertion that this is shown by every or by any physiological investigation is flatly contradicted by most of the investigators; but the assertion that *it can be stated without fear of refutation that so and so is true* is a pretty safe one, although a moment's reflection will show that there is no end to the things which may be stated without fear of refutation; that Mars is inhabited, for example, or that we are surrounded by good and evil spirits.

Another recent number of SCIENCE (p. 125) contains the statement, by one who is many times a President, that when protozoa move towards the light they 'seek' oxygen, and that in order to 'seek' it "they have to be aware that they need it, and must have some knowledge of the fact when they get it."

When we ask how the President knows all this we receive this most remarkable and characteristic answer: "It is impossible at present to assign any other cause to some of the movements of even the amœba."

A child can see that lack of proof is not evidence, and while it is impossible to prove that an amœba or an oak tree is not conscious and is not endowed with volition, the statement that they are so endowed is not science but poetry until some better evidence than lack of proof is adduced.

Even if positive evidence were found, even if it were proved that all nature is conscious, this would not be proof that consciousness and volition are or can be causes of structure.

If we admit, as I think we must, that, for all we know, an oak tree may have volition and may do as it likes, what evidence

is there that it ever likes to do anything which it would not do in any case, by virtue of its structure, even if it were unconscious?

If the President will give us evidence that volition is an agent in this sense of the word; that it can do anything which is not deducible from structure; that it can be a cause of structure; that any one by taking thought can add one cubit to his stature, I, for one, will hold him in the highest honor as the greatest of discoverers; nor do I believe that he will find me prejudiced, for I trust that I have done all that in me lies to refrain from preconception, and I simply want to know.

"If he possesses such knowledge he is just the man for whom I have long been seeking. All knowledge can be communicated, and therefore I might hope to see my own knowledge increased to this prodigious amount by his instruction." (Kant; translated by Huxley; *Hume*, p. 208.)

If the learned bodies which give their allegiance to the utterances I have quoted will publish the evidence which proves that consciousness and volition can cause structure or anything else, they will not only demonstrate their own scientific eminence, but, by settling a question which has never ceased to vex the mind of man, they will make the closing years of the nineteenth century memorable for all time by the greatest scientific discovery the world has seen.

In an article which was printed in *SCIENCE* in April, 1895, I urged the need for philosophic doubt on the problems of life, and I also took occasion to affirm my own opinion that the phenomena of vitality and of volition are so peculiar that these words are most useful ones in so much as they help to focus the most distinctive problems of biology.

I thought I had made it clear that my plea for these words is based on their value in helping us to keep difficulties in clear view

and not because they explain anything; and I have been much surprised by the receipt of a number of letters from Vitalists who welcome me as a new recruit.

No one likes to march alone; and both sides put the man who does not take sides with the enemy. We need all the comrades we can get in our weary way through life, and I regret the necessity which forces me to tell my correspondents I cannot fight under their banner; and that my only purpose in writing the article was to show that intolerance has followed the conversion into a belief, by pious Monists, of Huxley's carefully guarded declaration that he lives '*in the hope and in the faith*' that we shall some time be able to see our way from the constituents of living matter to its properties.

Nothing was farther from my thoughts than any dogmatic assertion that vitality and volition are outside the domain of physical matter and mechanical energy, or that they are agents, and I had in mind certain zoölogists who seem to me to be attempting to discount the possibilities of future discovery in defiance of the warning "that the assertion which outstrips evidence is not only a blunder but a crime."

Recent utterances seem to show that all the criminals are not among the materialists, and that the dogmatism of biologists must be attacked at both ends of the line.

In all seriousness we ask, what can fundamental disagreement among those who speak with authority lead to, except disaster? Are we not bound to find first principles which will command the assent of all thinking men?

Those who hold the creed that all the activities of animals and plants will some day be deduced from the properties of the physical basis of life are not likely to be influenced by any other opinion of the matter, whether this be called a belief, a hope or a working hypothesis; nor are those who hold that our will is free at all persuaded by those

who assert that volition is only an empty shadow of the changes which go on in the physical basis. So far as I can see, there can be no compromise between these opinions; and the *modus vivendi* is a device of the men of affairs, with which science has no concern.

Science still has many acute and well-trained enemies, and if they should concentrate their forces in an attack upon biology what better weapon could we place in their hands than our own failure to agree?

Honesty of purpose and expediency unite in the demand that we build biology upon a foundation which can never be shaken; and if we accept as our creed the assertion that while we do not know whether life is or is not different from matter, that while we do not know whether thought is or is not an agent, we should like to find out, we need fear no attack by anything in the universe or outside it.

I am tempted to add a word of comment on one of my letters, as it bears upon the case in point, and is a good illustration of a belief which is held because it cannot be disproved.

It is accompanied by a book in which the writer devotes literary training and skill which many a scientific writer might envy, and eloquence and enthusiasm worthy of any cause, to the thesis that the living world is the work of 'Biologos,' a being who is said to bear about the same relation to us as that which we bear to the plants which we cherish in our gardens from love of horticulture; a being who is very paternal, very loving, very sympathetic and very superhuman, but still very far short of omnipotence or omniscience.

The writer seems to forget that there is no new thing under the sun, and that ages ago the first of naturalists failed to secure appointment as successor to the head of a school where very similar views had been taught, on account of his refusal to advocate

them, not because he thought he could disprove them, but because he held that they are not supported by evidence.

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*BIBLIOGRAPHY AS A FEATURE OF THE
CHEMICAL CURRICULUM.**

WHEN the Chairman of the Committee on Didactic Chemistry sent me a flattering invitation to address the Chemical Section on some topic associating bibliography with instruction, I hesitated to accept, for it seemed to me that the matter was too obvious to require discussion; but later, as chairman of a committee whose duty it is to encourage, in every possible way and on all occasions, the indexing of chemical literature, I concluded it was my duty to seize the opportunity of saying a few words in favor of introducing bibliographical research into the chemical curriculum of our American colleges. Could this be generally done what a multitude of chemical indexes to special topics might be secured!

The matter is largely in the hands of the heads of the chemical departments in our institutions of learning. As in every branch of instruction, in order to impart to students a lively interest in the subject, the teacher should himself have practical experience in the approved methods of indexing. He might introduce the subject by a lecture on Chemical Literature, pointing out the most recent and the most useful books and serials in the several branches of the science, their special and relative values, and the best way to use them. The teacher might exhibit a sample index in MS., prepared on the index cards of the Library Bureau, and he might explain to those unfamiliar with library cataloguing the technical methods employed. He might also discuss the different ways of

*Read to the Chemical Section of the American Association for the Advancement of Science, Springfield Meeting, August, 1895.

classifying and grouping the data, and show the advantages and disadvantages of the chronological, the author-alphabetical and the topical arrangements. Quite early in the instruction the teacher should direct the attention of the students to the necessity of discrimination between catalogues, bibliographies and indexes, for these words are too often used either as synonyms or indifferently. He should inform the students that a *catalogue* is a list of books on all subjects in a certain collection or locality; that a *bibliography* is a list of the books on a given subject without regard to their position; and that an *index* is a systematically arranged list of the papers and researches on a definite topic contained in books and serials, with references to the same. The teacher might warn the students against regarding the compilation of indexes as drudgery, claiming on the contrary that the task involves an agreeable pursuit similar in its fascination to that of the hunter.

The best methods for securing intelligent work in bibliography may well be left to the judgment of those having charge of instruction. I merely suggest that some institutions find it feasible to require of candidates for the higher degrees in science (B. S., S. D. and Ph. D.) chemical dissertations accompanied by special indexes to the literature of the subjects under discussion. This is a part of the prescribed work for applicants for the degree of Ph. D. at the Corcoran Scientific School of The Columbian University, Washington, a distinction of which the Dean may be justly proud. The preparation of Indexes to Chemical Literature is also required of undergraduates at the University of Michigan by the professor in charge, who is himself a member of the committee of the American Association for the Advancement of Science, already referred to. As a specimen of the excellent work done under Professor Pres-

cott's direction, I may mention the 'Bibliography of Aceto-Acetic Ester,' by Paul H. Seymour, which has been honored by publication in the Miscellaneous Collections of the Smithsonian Institution. (No. 970, Washington, 1894, 148 pp., 8°.) A similar requirement is in force in the chemical departments of Cornell University and of the University of Cincinnati.

The amount and kind of bibliographical work to be required of students will unavoidably vary greatly in different institutions, and must depend in part on the extent of the libraries to which the students have access and in part on their linguistic capacities. In many cases it might be well to limit the requirements to works in the English language, or even to the publications of American chemists, but if thus restricted, completeness within these limits should be insisted upon.

The problem of getting these undergraduate indexes into print is a somewhat difficult one; obviously many would of necessity remain in MS. on the shelves of the college library and become available to a very small number. Some of the more carefully prepared indexes to topics of prime importance would always find channels of publication either in the serials issued by learned societies, in periodicals devoted to analogous subjects, or through the higher medium of the Smithsonian Institution. This difficulty vanishes, however, with respect to those universities that require candidates for higher degrees to *print* their dissertations, as is the custom in most countries of Europe. The U. S. Bureau of Education has furnished me with the following:

**List of Universities and Colleges which require Printed Dissertations before (or after) conferring the degree of Ph. D.: Clark University, Worcester, Mass.; College of New Jersey,*

**Additions and corrections are earnestly desired by the writer.*

Princeton, N. J.; Columbia College, New York City; Cornell University, Ithaca, N. Y.; Johns Hopkins University, Baltimore, Md.; Lake Forest University, Lake Forest, Ill.; Leland Stanford, Jr., University, California; Northwestern University, Evanston, Ill.; University of Colorado, Boulder, Colo.; University of Chicago, Chicago, Ill.; University of Indiana, Bloomington, Ind.; University of Kansas, Lawrence, Kan.; University of Michigan, Ann Arbor, Mich.; University of Minnesota, Minneapolis, Minn.; University of Virginia, Charlottesville, Va.; University of Wisconsin, Madison, Wis.; Vanderbilt University, Nashville, Tenn.; Western Reserve University, Cleveland, Ohio.

Allow me to call attention, in this connection, to the desirability of forming a complete collection of all printed dissertations of American universities, and to suggest that the Smithsonian Institution is the proper place of deposit for such a collection. The Institution already receives those issued by the John Hopkins University and is willing to give others a place. When the magnificent new Library of Congress is completed, a collection of American university dissertations could be well housed, and would make a really valuable addition to the treasury of books; eventually a catalogue of these works could be published, as has recently been done in France. (*Catalogue des Thèses de Sciences, 1810-1890, Albert Maire, Paris, 1892; Catalogue des Thèses de Pharmacie à l' Ecole de Pharmacie de Paris, 1815-1889, Paul Dorveaux, Paris, 1891; Catalogue des Thèses de Pharmacie soutenues en Province, 1803-1894, Paul Dorveaux, Paris, 1895*). It may be proper to state that I am attempting to catalogue all the printed chemical dissertations of American colleges for the *Supplement* to my 'Select Bibliography of Chemistry,' and I appeal to the members of the Chemical Section for assistance.

Finally, could bibliographical researches be introduced into the chemical curriculum of American colleges several advantages would ensue beyond the mere collection of indexes; such a procedure would train students to accuracy in making citations; it would encourage in them a disposition to give credit to earlier workers in the same field of research as their own; it would tend to enlarge their views as to the immense domain of chemical literature; it would lay foundations upon which the post-graduates might build more substantially in after years, and it would develop an appreciation of the historical aspects of chemistry, which busy workers in the laboratory too rarely have opportunities of cultivating.

H. CARRINGTON BOLTON.

AGRICULTURAL CHEMISTRY.*

AGRICULTURAL chemistry is a cosmopolitan science. It was founded by Liebig, of immortal memory. Its early apostle in France was Boussingault; in England, Gilbert; in America, Johnson. It is presumably that science most nearly allied to the sustenance of human life, and thus lies nearer than any other to the heart, or perhaps the stomach, of humanity. Its home is wherever a plant grows. Its devotees are found wherever a plowshare turns the soil. Its base lies in the study of the composition of the soil and the constitution of plants. Its superstructure rises high enough to touch the most abstruse questions of mineral and vegetable physiology and metabolism. Turning from philosophy to facts, we find this science linked indissolubly with the greatest industry of the world. There is scarcely a field or a forest which has not felt the impress of its power. From the field its domain has extended to the factory and the guidance and advice of the

* Read before Section of Chemistry of the American Association for the Advancement of Science, September 3, 1895.

chemist are sought for the further preparation of foods and fabrics for the use of man. It has also secured a place in the domain of public and advanced instruction, and even the conservatism of the great universities has yielded to agricultural chemistry a prominent place in the curriculum of studies. Both in this country and in Europe hundreds of special schools and experiment stations are found devoted largely to the service of agricultural chemistry and its coördinate branches of science.

The art of fertilizing the fields, at first purely empirical, has become an exact science. The methods of saving and recovering waste fertilizing products, at the present time, renders many great industries possible which otherwise would have to yield to the fierce competition which every human endeavor has to meet at this end of the century. Further than this the paternal efforts of agricultural chemistry extend and seek to recover from the mine and from the sea the elements of fertility apparently forever lost during the centuries that have passed.

The science of agricultural chemistry acknowledges, without stint, its indebtedness to the other fields of chemical work. In its very beginning it was the simple use of the principles of mineral analysis, applied to the soil and its products. By this means the parts of the plants which were derived directly from the soil were determined, and the surprising fact was thus developed that nearly the whole of the vast product of vegetable growth is a free gift of Heaven and not chargeable to the soil. This was the point of union between agricultural chemistry and meteorology, and the basis of the science of meteorology applied to agriculture. The supply of carbon dioxide and water to the growing plant becomes thus a problem of the profoundest interest to agriculture, and the chemist and physicist have thus been led to study the great problems of precipitation, drainage and

irrigation as affecting the products of the field. The best methods of disposing of an excess of rainfall, with the minimum loss of plant food due to percolation of water through the soil, are of no less importance. In connection with this, that treatment of the soil by chemical and physical means which will best prepare it to distribute the supply of moisture available to the advantage of the growing plant has been carefully studied.

Agricultural science has also drawn freely on the resources of organic chemistry. In agricultural products are presented to the students some of the most complicated as well as interesting organic compounds. In the growth of the plant are seen the wonderful resources of the vegetable cell in the way of chemical activity. The most renowned achievements of modern synthetic chemistry have consisted in the reproduction of some of the simpler forms of vegetable organic compounds. It will be admitted, without doubt, that the simple sugars are the least complicated of organic vegetable products, and these have been at last successfully made in the laboratory. The step from a hexose to a hexobiose seems indeed a short one, and yet it has not been taken. Only step by step must we expect the onward progress of synthesis until, for instance, a starch is reached. Yet in the progress of organic synthetic chemistry already accomplished, great good has come. The exact chemical relations of the sugars to the aldehyds, ketones and polyatomic alcohols have been established and the bonds which unite the organic chemistry of man to that of Nature clearly distinguished. On a former occasion, in an address to the Chemical Society, I have pointed out the futility of the expectation that synthetic organic chemistry will ever be able to take the place of agriculture, but the debt agriculture owes it is one of great and constantly increasing magnitude.

Not of less practical importance to agriculture has been the recent progress in our knowledge of that indefinite complex which has so long passed under the misnomer of 'nitrogen-free extract.' With the exception of the facts that it is not nitrogen-free and that it is not an extract, the name may do well enough. At least some agricultural chemists have an idea of what the term signifies, and to others it serves the purpose of the physician's malaria, permitting them to designate, in a fairly mysterious way, a something of which nothing is known. The constitution of the greater part of this complex body is now known, and the proportions of cellulose and of pentosans which it contains can be determined with a fair degree of definiteness. We should deem it a matter for congratulation to be assured that the day is fast approaching when the agricultural chemist will no longer be called on to determine forty per cent. or more of a cattle food 'by difference.'

In late years not only has organic chemistry helped us in the way of a better understanding of the composition of the carbohydrates, but it has also pointed out to us some of the main points in the constitution of those most valuable products, the vegetable proteids. We are far behind our digestive organs in our understanding of these bodies and have been accustomed in practical work to place all proteid matter together in a single class. But there is no doubt of the fact that the vegetable proteids differ as much among themselves as those of animal origin, and at last the chemist is able to distinguish between them. Even if it should prove that there is little difference in their food value, yet it must be conceded that a knowledge of their structural differences, together with the several contents of nitrogen found therein, will prove in the end of the greatest advantage to the agricultural chemist.

The relations of agriculture to pedagogic

chemistry have already been mentioned. In many of our public schools it is thought to be quite as important to teach the child something about the life of the field and the orchard as to drill him in the geography of Johore. How plants and animals grow is a theme which will one day be developed in every school in the land. Naturally, in agricultural colleges, the pedagogic side of agricultural chemistry receives due consideration, but alas! with these institutions it is sometimes *nomen et proterea nihil*. In these cases agricultural chemistry must often give place to a heterochronistic psychology. But, on other hand, many of our universities have recognized the need of such instruction and have provided properly therefor. Merely material considerations should induce all our higher institutions of learning to provide for advanced instruction in agricultural chemistry, for just now there is, and for years to come there will be, a large demand for young men well trained in this direction. It will not be many years before it will be required of every well-equipped university to provide liberally for the professional education of the young men who are to take charge of the agricultural colleges and experiment stations of the country.

In its relations to bacteriology, agricultural chemistry is also a debtor. In the life history of those minute vegetable organisms which exert so profound a chemical action on many bodies has been found the solution of the problem of those fermentations which prepare for use the nitrogenous foods of plants. The successive conversion of organized nitrogen into ammonia, nitrous and nitric acids is a process of the most vital importance to plant life. It is true that these activities were exerted for several millions of years without our knowing anything about them, and they would doubtless go on until the end of time if our knowledge of them should entirely

cease and determine. Nevertheless, the value of what little knowledge we now possess seems almost the groundwork of scientific agriculture. The micro-organisms which nitrify organic nitrogenous compounds, as well as those which act in the opposite direction, viz., in reducing nitrates to a lower form of oxidation, are of the utmost importance to agricultural chemistry. It is not beyond the range of possibility that a barren field may be rendered fertile by securing conditions favorable to nitrification and then seeding the soil with a few active nitrifying ferments.

Quite true it is, already, that any scheme for an analysis of a soil which leaves out of consideration the determination of nitrifying activity is far from complete. The action of bacteria on the ripening of cream and of cheese is a matter of but little less importance. The fermentation of cream and of cheese is already as much of an art as the fermentation of malt in the manufacture of beer. In the curing of tobacco the same activity is discovered and the day is not far distant when commerce in high bred tobacco bacteria will be an established fact. In short, we may look forward to the day when the bacteria active in agriculture will be carefully cultivated and the bacterial herd book will be found along with those of the Jersey cow and the Norman horse. Agricultural chemistry makes demands on every science which can aid it in the production of food and in the advancement of rational agriculture.

But we may go still a step further and follow the crude food into the factory and the kitchen. From the knowledge of the action of ferments mentioned above the great art of food preservation has been created. The sterilization of food products and their preservation from the further action of destructive ferments is one of the practical developments of rational agricultural chemistry. This method of food preservation is

infinitely preferable to that other simpler process which consists in adding to the food a substance which paralyzes the further action of micro-organisms. Happily, agricultural and analytical chemistry have provided a certain method of detecting chemicals thus used for food preservation.

The conversion of foods into appropriate digestive forms and the study of their nutritive power mark the final step in agricultural chemistry in its control of food products. In this relation it comes into intimate contact with hygiene and animal physiology, thus almost completing the circle of intimate union with nearly all the leading sciences. Intimately associated with this branch of the subject is the control of the purity of the food itself and the detection of the adulterations to which it may be subjected.

The thoughts suggested in the foregoing pages are those that have come to me amid a multitude of distractions as those suited, at least in part, to meet the views of your presiding officer in asking me to introduce the theme of agricultural chemistry for discussion before the Section. I now yield the floor for a more particular treatment of some of the branches of the subject.

H. W. WILEY.

PROCEEDINGS OF THE BOTANICAL CLUB, A.
A. S., SPRINGFIELD MEETING, AUGUST
29th TO SEPTEMBER 2d, 1895.

THE meetings were held in the room assigned to Section 'G,' in the State Street Baptist Church.

THURSDAY MORNING, AUGUST 29.

In the absence of the President, Prof. D. H. Campbell, and of the Secretary, Prof. F. C. Newcombe, the meetings of the Club were placed in organization by Prof. Geo. F. Atkinson. Hon. David F. Day was made Chairman *pro tem.*, and Prof. H. L. Bolley, Secretary.

On motion of Professor Atkinson, those having papers to present were requested to hand titles of the same to the Secretary upon the day preceding that upon which it was wished the paper should be read.

The meeting adjourned at 11:30 to meet at 9 A. M., Friday, August 30th.

FRIDAY MORNING, AUGUST 30.

The Club met as ordered, with President D. H. Campbell in the chair. In order to facilitate the reading of papers, the titles of which for the first time in the history of the Club now appeared printed in the regular daily program of the A. A. A. S., the reading of the minutes of the previous meetings was dispensed with.

The first paper presented was on 'Crimson Clover Hairballs,' by Mr. F. V. Coville. These balls, composed of the hairs of the Crimson Clover, *Trifolium incarnatum*, has been found in the stomach of a horse. Mr. Coville exhibited specimens, also mounted slides showing their composition.

Professor Byron D. Halsted reported the results of field experiments with beans. He had found that 25 per cent. of plants grown on soil previously occupied by beans were affected by spot, whereas when grown on new soil only six per cent. were diseased.

Mrs. Elizabeth G. Britton reported corrections upon descriptions of *Coscinodon*.

Mr. O. F. Cook remarked upon 'A Peculiar Habit of a Liberian Species of *Polyporus*,' and exhibited specimens showing various degrees of proliferation, one pileus arising from another upon very extended delicate stalks, due perhaps, to the extreme moisture of their environment.

An apparatus for the bacteriological sampling of well water was described and illustrated by Professor H. L. Bolley, the merits of which were facilities afforded for sterilization in toto, and in general accuracy of work afforded without contamination by air and water.

Mr. C. L. Pollard described the methods of work in the National Herbarium. The colored labels in use to designate type specimens were made of special interest, because of the new range offered for convenience of reference.

Passing to order of unfinished business, Dr. Trelease called for the report of the committee appointed at the Rochester meeting to prepare and print a check list of the plants of northeastern North America. Dr. N. L. Britton, as chairman of the committee, submitted the appended report:

"The Committee reports that it has completed the task assigned it by the Club at its Rochester and Madison meetings, by preparing, to the best of its ability, a list of plants in accordance with instructions received at those meetings. The Committee herewith presents a printed copy for such list, which has been prepared and published without expense to the Club.

For the Committee,

N. L. BRITTON,

Chairman."

Mr. O. F. Cook, seconded by Dr. F. H. Knowlton, moved the acceptance of the report. After some discussion as to the scope of the term 'acceptance' as here moved, an adjournment was taken until afternoon without action being taken upon the motion.

FRIDAY AFTERNOON, AUGUST 30.

Following the regular session of Section 'G,' the Club, upon further discussion, adopted the motion of Mr. Cook to accept the report.

On motion of Prof. L. H. Bailey the Club then proceeded to the discussion opened in the morning by passing the regular program.

On motion of Mr. F. V. Coville, seconded by Prof. E. L. Greene, and carried, it was resolved that the meeting proceed to a discussion of the principles on which the list was based.

Dr. B. L. Robinson then alluded to certain generic names which he thought had been inconsistently employed in the list. He also discussed the admission of specific names first published as synonyms. The practice of admitting such names was defended by Prof. Greene, who maintained that the practice of 'taking up of synonyms' as used by the committee was a principle established by Gray.

Prof. N. L. Britton also maintained that the principles adopted by the Club at the Rochester meeting required the admission of such synonyms as those cited by Dr. Robinson.

After much rambling discussion, the following resolution, offered by Professor Britton, and seconded by Professor L. H. Bailey, was adopted:

Resolved, That in view of the opinions which have been expressed at home and abroad on principles of nomenclature, during the progress of the work of the committee, the matter be referred to the committee for consideration and report at the next meeting of the Club.

Prof. Britton also introduced the following resolution:

Resolved, That the committee be increased to eleven members by the additions of Dr. B. L. Robinson and Dr. C. S. Sargent.

At this point Dr. B. L. Robinson stated that, because of the radical difference of opinion existing between himself and the majority of the present committee upon certain vital points, it was plain to him that he must decline to serve upon the committee. In compliance with these wishes, the Club reluctantly accepted Dr. Robinson's withdrawal, and upon motion Professor L. H. Bailey's name was substituted in the resolution, and the same adopted as amended. The Club then adjourned to meet at the same place at 9 A. M., Monday, September 2d.

MONDAY MORNING, SEPTEMBER 2.

Prof. N. L. Britton, Dr. W. H. Seaman and Mr. Walter Deane were appointed a committee to nominate officers for the next meeting. The report of Treasurer F. C. Newcombe, showing the balance in hand, \$6.57, was read and accepted.

The first paper was read by Mrs. Elizabeth G. Britton, entitled 'Some Notes on *Dicranella heteromalla* and allied Species.'

Prof. J. C. Arthur described a new form of clinostat, and remarked on its advantages over similar machines previously constructed, its great superiority being multiple arms for holding plants, allowing of checks upon tests made.

A paper by Mr. A. B. Seymour describing the Mary A. Gilbreth collection illustrating the dissemination of seeds, now the property of Radcliffe College, was read by Mrs. Flora W. Patterson.

Judge David F. Day described the dissemination of the seeds of *Zinnia* by means of the persistent ray-flowers.

Mr. Walter Deane mentioned the expulsion of the seed from the capsules of the Witch-hazel, *Hamamelis Virginica*, stating that he had observed them strike a pane of glass fourteen feet away with almost force enough to crack it.

Judge Day spoke also on the desirability of further observations on climbing plants, referring to his observations on the genus *Dioscorea*, some species of which twine in one direction, others in another. He mentioned *Aconitum uncinatum* as a twining plant, and had observed 'a secondary peduncle in *Anemone Virginiana* twining around the primary one.

The following papers were read by title during the meetings:

'Notes upon Pig-nut Hickories,' by William Trelease.

'Experiments with Lime as a preventive of Club-root,' by B. D. Halsted.

'Notes on the alkaline Reaction of the

vascular Juices of Plants,' by Erwin F. Smith.

'Continuation of Experiments upon the Relation between the fertile and sterile Lerves of *Onoclea*,' by George F. Atkinson.

'A Hybrid between an Egg Plant and Tomato Plant,' by P. H. Rolfs.

'A Method of using Formalin Gelatine as a Mounting Medium,' by A. F. Woods.

The committee appointed to nominate officers submitted the following names and they were unanimously elected:

President, Frederick V. Coville, Washington, D. C.

Vice-President, Conway McMillan, Minneapolis, Minn.

Secretary and Treasurer, J. F. Cowell, Buffalo, N. Y.

The Secretary was requested to append to the minutes for future reference a list of persons who have been officers of the Club since its formation.

The Club then adjourned to meet as usual during the meeting of the Association in 1896.

Fifty-three botanists were registered during the different sessions.

H. L. BOLLEY,

Secretary pro tem.

THE BOTANICAL SOCIETY OF AMERICA.

THE first annual meeting of the Botanical Society of America was held in Springfield, Mass., August 27 and 28, 1895. The Council, having all members present, met in the afternoon of the 27th. The consideration of names proposed for membership, the canvassing of ballots cast for officers and transaction of other business engrossed the attention of the Council for an hour and a half.

The Society was then called to order by the President, Wm. Trelease, of St. Louis. The first day's session and a portion of those of the second day were devoted to business.

Four new members were elected: Mr. M.

S. Bebb, of Rockford, Ill.; Prof. W. R. Dudley, of Leland Stanford University; Prof. D. P. Penhallow, of McGill University, and Dr. W. A. Setchell, of Yale University.

The following officers were elected for 1896: President, Prof. C. E. Bessey, of the University of Nebraska; Vice-President, Prof. W. P. Wilson, of the University of Pennsylvania; Treasurer, Prof. Arthur Hollick, of Columbia College; Secretary, Prof. Charles R. Barnes, of the University of Wisconsin. Councillors, Dr. B. L. Robinson, of Harvard University, and Prof. G. F. Atkinson, of Cornell University.

Dr. A. W. Chapman, of Apalachicola, Fla., was elected unanimously an honorary member of the Society. Dr. Chapman, the well-known author of a 'Flora of the Southern United States,' is the first honorary member to be elected. His advanced age, precluding active membership, and his pioneer services in making known the vegetation of the Southern States, were felt to be sufficient warrant for this action.

Contributions of books having already been received by the Society, it was ordered that such be deposited in the library of the Missouri Botanical Garden, subject to the order of the Council, and the Secretary be directed to report to the Society the annual additions.

The Treasurer's report showed a cash balance of \$354.

The following resolution was presented by Prof. L. H. Bailey at a session subsequent to the reading of Dr. Britton's paper on 'The New York Botanical Garden,' and was unanimously adopted:

Resolved, That the Botanical Society of America express its thanks to Dr. N. L. Britton for his account of the condition and progress of the movement for a botanical garden in the city of New York, and congratulate the people of that city on the prospect of its rapid development; and, furthermore, that the Society commend the

Board of Managers of the garden and its Board of Scientific Directors for their wisdom in securing a broad foundation and an assurance of liberal management.

The following papers were read before the Society:

Some notes on a revision of the genus *Mnium*, illustrated with specimens and photographs of types: ELIZABETH G. BRITTON.

The New York Botanical Garden: N. L. BRITTON.

A contribution to a knowledge of North American phycophilous fungi: GEO F. ATKINSON.

The genus *Liriodendropsis*: ARTHUR HOLICK.

The Laboulbeniaceæ: ROLAND THAXTER.

Notes on aquatic fungi: ROLAND THAXTER.

A synopsis of North American rushes: FREDERICK V. COVILLE.

Summary of a revision of the genus *Dicranum*: CHARLES R. BARNES and RODNEY H. TRUE.

Corrections in the description of *Coscino-don Rauei* and *O. Renauldi*, and a comparison of these species: ELIZABETH G. BRITTON

CHARLES R. BARNES.

UNIVERSITY OF WISCONSIN.

SCIENTIFIC NOTES AND NEWS.

A NEW JURASSIC PLESIOSAUR FROM WYOMING.

THE writer has recently been fortunate in finding in the Bapstanodon Beds of the Upper Jurassic of Wyoming the remains of a large Plesiosaur, the first of the group from the Jurassic found in America. The horizon is below that of the large Dinosaurs. The precise generic location of the specimen is at present difficult, until more of the specimen has been detached from the hard matrix. It is, therefore, placed provisionally in the genus *Cimoliosaurus*, to which the ascertained characters seem to refer it. The species may be known as *C. rex*.

A centrum of a dorsal vertebra measures

108 mm. in length by 130 mm. in transverse diameter. An anterior cervical centrum is deeply cupped on one end and nearly flat on the other, and measures 65 mm. in length by 80 mm. in width. The arch is united by suture, and the ribs have a single attachment. The femur is about 1200 mm. in length (a portion of the shaft is missing), 375 mm. in width at the distal end, and 300 mm. at the head. A basal phalange is 105 mm. in length, 65 mm. in width at either end and 37 mm. through the shaft.

A full description of the remains found will be shortly given by Professor Williston and the writer. W. C. KNIGHT.

THE EARLIEST NAME FOR STELLER'S SEA COW AND DUGONG.

IN 1811, Illiger published a number of new genera,* proposing among others, *Rytina* for the sea cow of Bering Island and *Halicore* for the dugong of the Indian Ocean. Nearly all recent writers on mammals have adopted these genera, apparently overlooking the fact that both animals had been named before 1811. As early as 1794 Retzius described the sea cow in the 'Handlingar' of the Stockholm Academy of Science, placing it in a new genus which he called *Hydrodamalis*,† and the species, based on the *Vacca marina* of Steller, *Hydrodamalis stelleri*. The generic description is sufficient to identify the animal even if the species and the vernacular name used by Steller had not been given. As *Hydrodamalis* has 17 years priority over *Rytina* it should be adopted as the generic name of the northern sea cow. The earliest specific name is that given by Zimmermann in 1780, and the species should stand *Hydrodamalis gigas* (Zimm.). The abandonment of *Rytina* necessitates a change in the name of the family (*Rytinidae*), which

* *Prodromus Syst. Mamm. et Avium*.

† Kongl. Vetensk. Acad. nya Handlingar, Stockholm, XV., Oct.-Dec., 1794, p. 292.

may be called *Hydrodamalidæ*, there being no other genus in the group.

Lacépède, in 1801, used *Dugong** as a generic name for the sirenian afterwards called *Halicore* by Illiger, but not being a classical word it did not come into general use. As it is the first name for the genus there seems to be no good reason for not adopting it. The specific name was first proposed by Müller in 1776,† who spelled it *dugon*—without the final g. This was evidently not a misprint, as the same spelling occurs twice. The name for the dugong will, therefore, be *Dugong dugon* (Müller), while the unfortunate compound *Dugongidæ* becomes necessary for the family, instead of the more euphonious *Halicoridæ*.

T. S. PALMER.

WASHINGTON, D. C.

AN INTERNATIONAL ZOÖLOGISTS' DIRECTORY.

MESSRS. FRIEDLÄNDER & SON, of Berlin, have just issued a very useful 'International Zoölogists' Directory' of 740 pp. octavo, containing about 12,000 names and addresses. It includes to a certain degree the official position of each person, for it is not a simple alphabetical list, but has several subdivisions, the classification being primarily geographical by countries. Under the country the towns are given alphabetically, excepting that the capital is placed first. Under each place are given, first, names of those attached to the different educational and scientific institutions (each institution apart), and here the names are given in the order and with the specification of their rank; unattached names follow alphabetically; some names, therefore, appear more than once, but only once in full. There is much supplementary information in brief statements regarding the publications of the different institutions. The specialties of each person are given in

* Mém. de l'Institut, Paris, III, 1801, Nouv. Tabl. Méthod., p. 501.

† Natursystems Suppl., 1776, pp. 21-22.

an abbreviated form, and the names are again classified in a scientific register (37 pp.) at the end under each specialty, and here names of those not authors and merely collectors are designated by an asterisk. Dealers and natural history artists are given last and separately under each place. Separate geographical and personal indexes enable us quickly to find what we may seek in the volume. It is excellently planned and admirably executed. We hope it has come to stay, but it will need constant revision.

NATURAL SCIENCE TRAINING FOR ENGINEERS.

IN an article in the *Engineering Magazine* for September, Professor N. S. Shaler considers the question "as to the share of natural science which should be incorporated in the several four-year courses leading to the bachelor's degree in the departments of civil, electrical, mechanical and mining engineering." The reorganization of the Lawrence Scientific School of Harvard University has made the investigation of this question desirable, and the results of the inquiry have to a great extent been embodied in its schemes of instruction. Sound general instruction in physics, knowledge of the principles of chemistry, an elementary course in geology, a good theoretical training in metallurgy, a certain amount of determinative mineralogy and an elementary half course in geography are enumerated as necessities for every engineer. The time required for the study of these subjects is about four-fifths of the study period of a college year, which is evidently excessive. Prof. Shaler considers that the burden of the student may be considerably lightened by attendance at the summer school of the University, when each student is required to give his time to one course. "It has been found that the six weeks' term, owing to the concentration of attention, serves to carry the pupil

quite as far as he is likely to advance in an ordinary year of work. * * * Including the year of his entrance, a student has four summers at his disposal before attaining his bachelor's degree. By giving up six weeks of each of three vacations he may win all the time required for the elementary science courses which are to be expected of the engineer." The latter part of the paper is devoted to the requirements of engineers who wish to be fitted for any one of the several branches of the profession, and considers in turn mechanical, electrical, marine, hydraulic, topographical and mining engineering, for each of which it is necessary that work in particular sciences should be carried to a higher plane. Professor Shaler considers it "an open question as to whether our science schools are not going too far in the effort to acquaint their students with the details of the several departments of engineering. * * * It is likely that in the end our schools will confess a limitation in their work and win firm ground by acknowledging that their province is to give the student a thorough education in the original sense of the word, supplying him with a large theoretical outfit, leaving the technique of his occupation to the time he begins work in a particular employment." Another argument for this point of view is that the education of an engineer differs from that of candidates for other professions. The classics and much else studied with the sole object of culture are perforce omitted. Professor Shaler says: "While I fully believe that natural science can do an excellent part in the civilizing process, it cannot do this if the teaching be devoted to immediate ends. The work must be done in the large, truly academic way; it must take the subject for itself, and not as a mere means to a professional result." The article concludes with a plea for the addition of one year to the curriculum of the technical schools: "While

the way to a profession through the path of the college may be held to be too long, that through the technical school is clearly too short for the needs of the work their graduates have to do." The extra year, besides making it much easier to add a fitting amount of natural science to the curriculum of the engineer, would also be a decided gain in the opportunities for studying English, French and German, and would admit of a more advantageous distribution of professional studies than can be accomplished under the present system.

GENERAL.

PROFESSOR C. L. DOOLITTLE writes that the University of Pennsylvania has begun the erection of an Astronomical Observatory, the purpose being to furnish facilities for instruction in astronomy and for original research. The site is five miles west of the present University buildings, being two miles beyond the city limits. The principal instruments are an 18-inch Equatorial, with Spectroscope, a Meridian Circle and a Zenith Telescope, each of 4 inches aperture. The optical parts are by Brashear, the instrumental by Warner & Swasey. As the Observatory Library is for the most part a thing of the future, any publications relating to astronomy or allied subjects which may be sent will be very acceptable. At present the Observatory has nothing to offer in exchange, but hopes to have at a future time. Contributions may be sent to The Flower Observatory, University of Pennsylvania, Philadelphia.

MR. O. H. TITTMANN, assistant in the Coast and Geodetic Survey, has been appointed delegate from the United States to the International Geodetic Association that meets in Berlin on the 30th inst., and sailed from New York on the 17th.

PROFESSOR ERNST RITTER, whose appointment as assistant professor of mathematics

in Cornell University, was recently announced, died on September 23d, of typhoid fever, on his arrival from Germany. The New York *Tribune* gives the following particulars concerning his life: Ernst Ritter was born at Waltershausen, Germany, on January 9th, 1867. He spent twelve years at the gymnasium at Gotha, and afterwards studied mathematics and natural science under Thomas, at Jena, and under Klein and Schwartz, at Göttingen. In 1890 he passed the government teacher's examination with the highest distinction, after two years of pedagogical work at Cassel, and at the Wöhlerschule in Frankfurt. He took the degree of Ph. D., *summa cum laude*, at Göttingen in 1892. In 1893 he was appointed assistant to Professor Klein, and began to devote his entire time to mathematics, contributing regularly to mathematical periodicals. Last year he lectured on geometry and the theory of automorphic functions, in which he was an authority. He was appointed to his Cornell professorship last June.

THE death is announced of Samuel C. Booth, mineralogist and naturalist. Mr. Booth began life as a poor farmer, but at the age of fifty years had gained a competency. He spent, however, much time in scientific study and became recognized as an authority in his chosen branches, and was able to leave behind much valuable information on scientific subjects, and a collection of rare minerals.

THE Institute of France has appointed a large and influential committee to further the object of erecting a statue of Lavoisier at Paris. It has been decided to make the memorial international and the committee have issued a circular asking help from all who wish to do honor to the memory of the great chemist.

THE Danish Academy of Sciences offers five prizes for papers which must be pre-

sented before the end of October, 1896, to Secretary of the Academy, Prof. G. H. Zeuthen, Copenhagen. The subjects are as follows: (1) The Electrolysis of Organic Substances; the gold medal of the Academy valued at 320 kr. (2) Algebraic Equations with their Numerical Coefficients in Relation to the Abel Equations; the gold medal of the Academy. (3) Field Mice and their Food; prize of 400 kr. (4) The Physical Constitution of Cultivated Earth; prize of 600 kr. (5) The bacteriological products in sour milk; prize of 400 kr.

LA Société de Médecine Publique et d'Hygiène Professionnelle, according to an announcement in the *British Medical Journal*, offers a prize for an essay on the following subject: 'Preventable Diseases; Means of Preserving Oneself from them and Preventing their Diffusion.' The prize is open to competitors of all nationalities. The essays, which must be written in French, must be sent in—with the usual precautions as to anonymity—before October 10th, to M. Cheysson, 115 Boulevard St. Germain, Paris. The first prize is of the value of £48, the second of £32. The sum of £20 will be distributed among 'honorable mentions.'

PROFESSOR HALLOCK writes that, in the list of colors given in the abstract of J. H. Pillsbury's paper on page 353, green should be inserted, making the colors: red, orange, yellow, green, blue and violet, with black and white.

THE Third South African Medical Congress was held at Durban from July 12th to 19th.

IT is reported that news has been received from a Danish trading station that a three-masted ship corresponding to Dr. Nansen's vessel, the 'Fram,' was seen by Eskimos last July embedded in an ice drift, and somewhat to the southward of 66° N. latitude.

UNIVERSITY AND EDUCATIONAL NEWS.

PROFESSOR W. A. SETCHELL, of Yale University, has accepted a call to the chair of botany in the University of California, vacant through the removal of Professor E. L. Greene to the Catholic University of Washington.

A SUIT has been brought by Yale University against Storrs College to determine the disposition of the Government appropriation (about \$20,000 a year) to agricultural colleges. This money was paid to Yale University from the time the fund was appropriated, in 1862, till it was diverted to the fund of Storrs College, in 1893. Since this date the money has been tied up by reason of the suit of Yale University to restrain the Treasurer from paying the money to Storrs College.

PROFESSOR HENRY TALBOT has been appointed associate professor of chemistry in the Massachusetts Institute of Technology.

THE following changes have been made in the medical faculty at Yale University: Dr. Cheney and Dr. Henry L. Swain have been appointed to professorships; Dr. Oliver T. Osborn and Dr. Louis S. DeForest have been made assistant professors, and Mr. C. J. Bartlet instructor in bacteriology.

QUEEN'S COLLEGE, Belfast, Ireland, attains its jubilee this year. It has been, however, resolved to postpone the celebrations till next year, when it is hoped that many alumni from different parts of the world will find it possible to be present.

THE number of Freshmen admitted to Harvard University by examination is 465, as compared with 418 last year. The scientific school shows a gain of 22 students; 104 were admitted this year as compared with 84 last year.

THE Freshman Class at Williams College, the largest in its history, numbers about 124 members. The Freshman Class

at Boston University, also the largest yet assembled, shows an increase of 50 over last year.

CORRESPONDENCE.

PROFESSOR HALSTED REPLIED TO.

EDITOR OF SCIENCE: Your number of September 6th appeared while I was in Europe, so that I am late in replying to an extraordinary charge made against me on page 309 by Professor Halsted, as follows:

"This letter of Beez incited Dr. McClintock to an examination of Beltrami's article and a paper on it under the title 'On the early history of the non-Euclidean geometry,' where, among other mistakes, he makes one peculiarly entertaining. He says, p. 145, Bulletin, Vol. II., of Saccheri: 'He confessed to a distracting heretical tendency on his part in favor of the hypothesis anguli acuti, a tendency against which, however, he kept up a perpetual struggle (diuturnum proelium). After yielding so far as to work out an accurate theory anticipating Lobatschewsky's doctrine of the parallel-angle, he appears to have conquered the internal enemy abruptly, since, to the surprise of his commentator, Beltrami, he proceeded to announce dogmatically that the specious hypothesis anguli acuti is positively false.' Who would suspect that all that is a pure fairy tale evolved by Dr. McClintock from his mistranslation of a passage immediately announced by the two Latin words he fortunately retained in parenthesis?"

This is all that Professor Halsted now says of my paper which he names and from which he quotes. He does not mention that half of that paper consists of a brief but careful resumé of the claims of Gauss, to which he devotes so large a part of the review to which I am replying, nor does he recollect that at the time when my paper appeared he wrote me (April 17, 1893), "I was delighted with your article on the Early History of the Non-Euclidean Geometry," giving no hint of dissatisfaction, but going on among other things to refer to an earlier paper of mine as 'your epoch-making article on the Non-Euclidean Geometry.' He sent me a second letter on April 27, 1893, again of the friendliest and most appreciative sort, but not referring to the paper in question; showing that the half on Saccheri as well as the half on Gauss met at that time with no disapproval on his part.

Professor Halsted has since added to our obligations to him as the bibliographer of this subject by obtaining the original Latin treatise of Saccheri and translating it into English. He found from the beginning that the two words quoted by Beltrami and from Beltrami by me, *diuturnum prælium*, were meant by Saccheri to indicate a mental attitude of constant war against the 'hypothesis' as heretical, without any such 'struggle' in his own mind as he appeared, from my reading of Beltrami, to have 'confessed.' 'The words of Beltrami are not inconsistent with my rendering of the two Latin words.

In May, 1894, on Professor Halsted challenging my word 'confessed,' etc., and sending me his Latin copy of Saccheri, I denied my mistranslation of what Beltrami had set before me, though acknowledging that I had, through the ambiguity of my material, credited Saccheri with a confession of what he did not confess (though he doubtless felt it, as intimated by Beltrami), the 'distracting heretical tendency.' In the last letter which I find on this subject from Professor Halsted, May 8, 1894, he says properly: "In my interpretation of the facts as they exist in the book I am inclined to go much further than Beltrami or yourself. But I wish to distinctly separate historic fact from interpretation, however probable or however much called for." There was no hint that I should publish any correction. I assumed that he would make the case clear in bringing out his translation of Saccheri.

The reader will now observe that I am charged with 'other mistakes,' of which no specification is or has ever been given, publicly or privately, and will form his own judgment. He will kindly note that I am charged with 'mistranslation,' after I had quoted to Professor Halsted the Italian and Latin context of the two Latin words in question and received no reply expressing dissatisfaction, and will form his own judgment. He will finally remark that my references to Beltrami's surprise, etc., are ridiculed as a 'pure fairy tale,' contrary to the fact, by this usually staunch upholder of historical accuracy, and will form his own judgment. And after all he will probably form a wholly incorrect judgment of Professor Hal-

sted's motives, however correct it may be of his imprudence; for I have had too many proofs of personal friendliness from him not to feel sure, in spite of this injury he has done me, that he had no idea that his hasty phrases could injure me, and no motive other than that of 'pointing a moral' for the moment.

EMORY MCCLINTOCK.

MOREISTOWN, Sept. 24, 1895.

SCIENTIFIC LITERATURE.

The Climates and Baths of Great Britain. Vol. I. London and New York, Macmillan & Co. 1895. 8vo. pp. xvi+640.

This volume contains the first part of the report of a Committee of the Royal Medical and Chirurgical Society of London, which Committee was appointed in 1889 to investigate certain questions relating to the climatology and balneology of Great Britain and Ireland, and includes the results of correspondence with medical men, of personal investigations by members of the committee and of the analysis of meteorological and medical statistics relating to the various localities. This first volume relates to the climates of the South of England and the chief medicinal springs of Great Britain.

The chairman of the Committee is Dr. W. M. Ord, of London, and his name is a sufficient guarantee of the accuracy and scientific impartiality of the statements made. In his introductory remarks he points out the contrast between England and Continental Europe from the point of view of the seeker of health, the former furnishing chiefly seacoast resorts while the main sanatory resources of the continent are inland and mountainous.

While a large part of this report is mainly of local interest, being intended especially as a guide to English physicians in prescribing certain health resorts to certain classes of patients, the general principles upon which its recommendations are based are as applicable to many American resorts as they are to the English ones. For example, much of what is said as to the class of cases which may hope for benefit or as to the other class of cases which are likely to be injured by the hot waters of Bath is equally applicable to the Hot Springs of Virginia or of Arkansas. So far as seaside resorts

are concerned, England is peculiarly fortunate in having such a number and variety of them on the southern coast, which presents great differences in outline, soil and climatic influences of various kinds. Dr. Ord remarks that "where a ridge comes down from high inland into the sea, its shelving sides are found to embrace great differences of climate within a small area. We may find one side of a bay exposed to east winds, with an air which is found to be tonic and bracing, while, on the other side, with a westerly or southwesterly aspect, the sun pours in on a beach lying at the foot of high cliffs with almost tropical warmth; and one side of a headland may be so warm as to be held to be relaxing, while the other is cool and invigorating."

In the section on the Climate of Devonshire attention is called to the fact that for years this region has been considered as specially favorable for those suffering from all forms of respiratory trouble, and the reporters, Dr. Symes Thompson and Dr. Lazarus-Barlow, say "from this cause it comes about that a large proportion of the permanent residents have become such from either some actual or hereditary tendency to diseases of the respiratory type." To this it might be added that so far as consumption is concerned, any locality to which large numbers of persons affected with pulmonary tuberculosis have resorted for a number of years is specially liable to be infected with the specific bacillus from dried sputa, wherever this has been deposited in more or less dark places.

In speaking of one locality the significant remark is made that "typhoid fever has virtually disappeared from Sandown since the new water supply was established in 1863."

The really valuable thermal and mineral springs of Great Britain are comparatively few in number. There are no alkaline waters. Bath and Buxton are the only thermal waters of importance. Harrogate and Strathpeffer are the chief sulphurous spas, and the strongest saline waters are those of Droitwich and Nantwich. There are no chalybeate springs of great reputation, but there are several which have considerable value.

Considering the great number and variety of

thermal and mineral waters in the United States, many of the springs containing considerable quantities of salts, having important therapeutic qualities, it is much to be desired that a scientific, impartial report upon them, similar to the one above referred to, should be prepared and published for the benefit not only of our own people, but of the world at large. No doubt at present it would be impossible to obtain the requisite data, for while we have a fair amount of reliable chemical analyses of the different waters, the statistics of disease and death are for the most part wanting and the meteorological data are still incomplete, although much has been done in this direction within the last ten years.

In the meantime, until we can have such a report of our own, those who are interested in health resorts, whether as physicians, patients, or friends of the sick, will find much in this volume to interest and instruct them.

J. S. BILLINGS.

Leitfaden für histologische Untersuchungen. VON DR. BERNHARD RAWITZ, Privatdozenten an der Universität Berlin. Zweite umgearbeitete und vermehrte Auflage. Pp. 148, no figures. Verlag von Gustav Fischer, Jena, 1895.

The purpose of this work, as the title states, is to furnish a guide to histological investigation. It is divided into two main sections. The first is devoted to the methods of histology, fixing, hardening, sectioning, staining, etc., and the principles involved in these proceedings. The second part takes up all of the tissues and organs and shows how the methods are applied. Cross references are constantly given, so that only a minimum of repetition is necessary.

The author's preparation for the task has been excellent. Besides the training of the German laboratories, he has prepared an excellent manual of histology and has written several papers giving the results of his own histological investigations.

In going carefully over the methods one can see the discrimination that has been exercised by the author in selecting, from the great number of possible methods, those that his own experience and that of others have found most reliable and most capable of giving the best gen-

eral results. The book seems to be a thoroughly trustworthy guide to modern histology. The author emphasizes the need of keeping physiology constantly in mind in studying morphology; this is one of the crying needs of morphological study at the present time, and it may be safely predicted that future advances will most often be made by those who see in morphology the agent or material vehicle of physiology.

Unlike most guides to investigation in which a microscope is necessary, this one omits all consideration of the instrument of the investigator. The author believes that as the microscope is a physical instrument it should be studied in a course on physics. He stands nearly or quite alone in this respect. Most teachers have found that the special application of an instrument could best be taught in actually applying the instrument to the investigation, and the best instructor is the one who has had experience in the use of the special instrument, it being always understood, of course, that the teacher has an adequate knowledge of the theory of the instrument. The author also believes that in a work on histology the methods by which the results are obtained should find no place, but be in a separate volume. He is here also largely in a minority, as the best works on modern histology give the methods by which each preparation has been obtained. This is sometimes given with the preparation or at the end of the chapter. The advantage is that a student can follow exactly the method of the book he is studying and avoid the confusion of being compelled to make his own selection from several methods. The uncertainty as to the cause of any failure is thus largely eliminated.

From the standpoint of a teacher who has had much experience with students, the reviewer is compelled to say that it would require one of experience to make the best use of this guide, as in many, if not the majority of, cases the directions are so brief that a beginner would find it impossible to fill the gaps. For one with experience, however, the book would serve an excellent purpose, for its directions include many late methods, and the general discussions are very suggestive. A drawback for the teacher is the lack of references to the sources of the

various methods given. Credit is given, as Ranvier's method, etc., but no reference to the place in which the full discussion can be found, and certainly in a book serving as a guide to investigation—and this professes to be such—the investigator should be given every aid. The *Microtomists' Vade Mecum* of Leé is far more satisfactory in this respect.

In a word, the book, with all its excellencies, is too brief for beginners without experienced teachers, and for the advanced worker the lack of references to original sources detracts greatly from its usefulness. S. H. G.

SCIENTIFIC JOURNALS.

PSYCHE, OCTOBER.

THE number is almost exclusively given to a revision of the species of the orthopteran genus *Spharagemon* by A. P. Morse. The author divides it into three series: *bolli* (with 4 species), *æquale* (3) and *collare* (2); but he further divides *S. collare* into no less than six races, to which he gives names; considerable change in the synonymy results. Excellent outline figures are given of the face of six of the commoner species with a few other characteristic parts. Three new species are briefly described. The genus is strictly North American and has not been found west of the Sierra Nevada. Mr. Morse expresses no definite opinion regarding the intimacy of its relationship to *Dissosteira*, under which Saussure placed it as a subgenus.

NEW BOOKS.

Report of the Chief of the Weather Bureau for 1893. Washington. Government Printing Office. 1894. Pp. 319.

The Forces of Nature. HERBERT B. HARROLD and LOUIS A. WALLIS. Columbus, Ohio, the authors. 1895. Pp. 159.

Psychology in Education. Ruric N. Roark. New York, American Book Company. 1895. Pp. 312. \$1.00.

The Herschels and Modern Astronomy. AGNES M. CLERKE. New York, Macmillan & Co. 1895. Pp. vi+224. \$1.25.

Justus von Liebig, His Life and Work (1803-1873). W. A. SHENSTONE. New York, Macmillan & Co. 1895. Pp. vi+215. \$1.25.